# Quasi 2-Layer Morphodynamic Model

# 28*th* Scottish Fluid Mechanics Meeting
# Quasi 2-Layer Morphodynamic Model

Sergio Maldonado & Alistair G.L Borthwick
School of Engineering, University of Edinburgh
King's Buildings, Edinburgh, EH9 3JL, UK

28th May 2015

## Abstract

Conventional 2DH morphodynamic models are typically based on a coupled system of hydrodynamic equations, a bed-update equation, and a sediment-transport equation. However, the sediment-transport equation is almost invariably empirical, with numerous options available in the literature. The morphological evolution of the bed predicted by a conventional model can be very sensitive to the choice of sediment-transport formula[1]. The present model is a physics-based alternative, free from empirical formulations for sediment transport rates, where the shallow water-sediment-mixture flow is idealised as being divided into two layers with variable (in time and space) densities: the lower layer concerned with bed load transport, and the upper layer representing sediment in suspension. The model is referred to as a Quasi-2-Layer (Q2L) model in order to distinguish it from typical 2-Layer models representing a stratified flow comprising two layers with different but constant and uniform densities. The model has been satisfactorily validated against widely-used empirical expressions for bed load and suspended transport rates. Then, a study concerning the migration of a 1D submerged erodible hump due to the effect of a current is considered. This case proves that the Q2L model, in contrast with conventional morphodynamic models, captures correctly the physics of the phenomenon by inherently including the influence of the bed slope on the sediment transport. This conclusion is verified by validating the model against experimental data from a steep sloping duct[2]. Furthermore, the model is applied to the analysis and quantification of the bed-slope-influence through a diffusivity parameter that can modify empirical sediment-transport formulae (derived for horizontal beds) in order to account for the effect of a sloping channel[3]. The present physics-based approach thus represents an alternative tool that can be potentially used to investigate sediment-transport phenomena, whose adequate analysis cannot be undertaken following the conventional approach. The Q2L model can also lead to the enhancement of conventional 2DH morphodynamic models.

## References

[1] Dissanayake, D. M. P. K., Roelvink, J. a., & van der Wegen, M. (2009). Modelled channel patterns in a schematized tidal inlet. *Coastal Engineering*, *56*(11-12), 1069–1083.
[2] Damgaard, J. S., Whitehouse, R. J. S., & Soulsby, R. L. (1997). Bed-Load Sediment Transport on Steep Longitudinal Slopes. *Journal of Hydraulic Engineering*, *123*, 1130–1138.
[3] Johnson, H. K., & Zyserman, J. a. (2002). Controlling spatial oscillations in bed level update schemes. *Coastal Engineering*, *46*, 109–126. http://doi.org/10.1016/S0378-3839(02)00054-6